

for the benefit of travellers, in which the floating glass was part of the plan.

In obtaining the position of a ship at sea the difficulty is to get observations both for latitude and longitude at the same time, as all other observations depend on the distance covered by the vessel in the time which has elapsed between the observations. Now, as this distance depends not only on the direction and rate of the vessel through the water, but also on the direction and rate at which the water itself is moving, and as this latter element in the calculations cannot be ascertained with precision, it follows that all observations at sea which depend on the ship's run in the interval have an element of uncertainty. The best time to obtain simultaneous observations for latitude and longitude is at twilight, morning and evening, as then the horizon is clear, and, unless the weather is very cloudy, some stars can be seen. Here Sumner's method is invaluable, as three or more stars can be utilised and the correctness of the result guaranteed, provided, of course, that the chronometer is correct. In the day-time the only chance to obtain simultaneous observations is when the sun and moon are both visible, or when Jupiter, or Venus, happen to pass the meridian at an interval of over $2\frac{1}{2}$ hours from noon, as then, in bright weather, their meridian altitudes can be obtained by a practised observer with a good sextant.

One of the difficulties in obtaining good results at sea is owing to the varying nature of the refraction, more especially close to the horizon. This may be guarded against in the case of the meridian altitude of the sun by observing, when practicable, its altitude with the north and south horizons. To show the closeness of the results ascertained in this manner, it is only necessary to observe that H.M.S. *Triton*, when fixing the position of the Ower and Lemon light-vessel on the east coast of England in 1884, obtained the latitude on four different days, the results being as follows :—

June 25	...	...	...	Lat. $53^{\circ} 7' 56''$ N.
July 9	...	...	...	" $53^{\circ} 8' 0''$ N.
July 11	...	...	...	" $53^{\circ} 7' 54''$ N.
July 12	...	...	...	" $53^{\circ} 7' 57''$ N.

an extreme range of $6''$, or 600 feet, in the latitude. Such a close accordance shows the value of this method, which is recommended by Raper.

As regards obtaining the longitude by lunar distances, this has been gradually falling into desuetude owing to the quicker passages made by vessels and to the cheapness of chronometers. There can, however, be no doubt of its utility, as it is the only good way of obtaining the position of the ship at sea should any accident happen to the chronometers, and it is to be regretted that it is so seldom practised, particularly when we remember the excellent results obtained by the older navigators, especially by Cook. For the actual observation the repeating circle is a far better instrument than the sextant, as by it the distance between the sun and moon is observed with much greater accuracy, a matter of the utmost importance when we remember that an error of one minute in the distance makes an error of twenty-five miles of longitude under the most favourable circumstances. It is therefore evident that this observation requires to be made with the utmost care and that constant practice is necessary to obtain good results.

In the problem of obtaining the true bearing of a terrestrial object from a ship at sea, Mr. Merrifield has omitted the correction of the angular distance due to the height of the object: this is probably an accidental omission, but although it does not usually amount to much, it is desirable the student should be acquainted with it.

LETTERS TO THE EDITOR

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.]

[The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.]

Laws of Solution

In my paper on "Chemical Affinity and Solution," published in NATURE, vol. xxxiii. p. 615, I gave some general proofs (taken from Thomsen's researches on thermo-chemistry) of the truth of my theory of solution. I shall now show that there are certain well-marked and definite laws of solution which are in complete accord with that theory, and seem to me to place it beyond doubt. In all chlorides, bromides, iodides, sulphates, and nitrates, for which data are available, the heats of solution in water vary directly—

- (1) As the affinity (measured by heat of combination) of the positive element of the salt for O varies;
- (2) As the affinity (measured by heat of combination) of the negative element or radicle of the salt for H varies;

And inversely—

As the affinity (measured as above) between the positive and negative elements of the salt varies.

The following examples will make this plain :—

Compound	Heat of combination	Difference	Heat of solution of chloride	Difference
[Mg, Cl ₂]	151010	—	35920	—
[Mg, O, Aq]	148960	2050	—	—
[Ca, Cl ₂]	169820	—	17410	+ 18510
[Ca, O, Aq]	149260	20560	—	—
		- 18510	—	+ 18510
[Ca, Cl ₂]	169820	—	17410	—
[Ca, O, Aq]	149260	20560	—	—
[Sr, Cl ₂]	184550	—	11140	+ 6270
[Sr, O, Aq]	157780	26770	—	—
		- 6210	—	+ 6270
[SrCl ₂]	184550	—	11140	—
[Sr, O, Aq]	157780	26770	—	—
[Ba, Cl ₂]	194740	—	2070	+ 9070
[Ba, O, Aq]	158760	35980	—	—
		- 9210	—	+ 9070

Similar results are obtained if we substitute the alkali metals for above, but there is a variation in the case of metals which form insoluble oxides or hydrates. In the latter case the heats of solution are not so great as they should be if compared with above compounds. Among themselves, however, they follow the laws pretty closely, and seem arranged in groups. Thus, ZnCl₂ and CdCl₂, FeCl₂, CoCl₂, and NiCl₂ form two such groups.

The foregoing examples illustrate the effect of the change of the positive element of the salt on the heat of solution. Now let us change the negative element and we shall see the same result.

Compound	Heat of combination	Difference	Heat of solution	Difference
[K, Cl]	105610	—	-4440	—
[H, Cl, Aq]	39315	66295	—	—
[K, Br]	95310	—	-5080	+640
[H, Br, Aq]	28380	66930	—	—
		-635		+640
[K, Br]	95310	—	-5080	—
[H, Br, Aq]	28380	66930	—	—
[K, I]	80130	—	-5110	+30
[H, I, Aq]	13170	66960	—	—
		-30		+30

These relations obtain for the haloid salts of all the metals for which data were available for comparison. The only exception is AuCl_3 and AuBr_3 , the difference of heats of solution of these salts being too great according to the foregoing laws. They are apparently proportional, however.

There is another way of showing these laws and also of showing the conditions which determine the absolute amount of heat of solution, whether positive or negative. If we take the sum of the heats of formation of any salt and of water on the one hand, and on the other, instead of measuring the heat of solution directly, take the sum of the heats of formation of the oxide, of the acid and of neutralisation, we shall find that the heat of solution is the difference of these sums—positive when the latter sum is the greater, and negative when it is the less. This exhibits in a striking manner the relations of the various affinities to solution, and is very suggestive when we consider that the heat of solution regularly increases with the heat of formation of $[\text{M}, \text{O}, \text{Aq}]$, and when the heat of $[\text{MO}] > [\text{M}, \text{Cl}_2]$, decomposition of water takes place. Consider the following examples:—

Compound	Heat of combination	Compound	Heat of combination
[Mg, OAq]	148960	[Mg, Cl ₂]	151010
[2H, Cl, Aq]	78630	[H ₂ O]	68360
Neutr.	27690		
	255280		219370
	219370		

Difference 35910 = Heat of solution.

[Sr, O, Aq]	157780	[Sr, S, O ₄]	330900
[H ₂ , S, O ₄ , Aq]	210770	[H ₂ , O]	68360
Neutr.	30710		
	399260		399260
	399260		

Difference 0 = Heat of solution. Salt insoluble.

[K ₂ , O, Aq]	164560	[K ₂ , N ₂ , O ₆]	242970
[H ₂ , N ₂ , O ₆ , Aq]	102190	[H ₂ , O]	68360
Neutr.	27540		
	294290		311330
	311330		

Difference - 17040 = Heat of solution.

The above illustrate the cases of positive, negative, and zero heats of solution. These relations obtain with all salts, whether the oxide is soluble or not. The only discrepancy I found was in the case of silver chloride, which showed a slight negative heat of solution; but as its affinity for O is excessively small, it is not surprising it should be an abnormal case.

These laws of solution explain and are illustrated by many cases of constant differences in the heats of formation of similar compounds in water. Thus it has been pointed out in Muir and Wilson's "Thermo-Chemistry" that between the heats of formation of soluble chlorides, bromides, and iodides in water, there is a constant difference, no matter what the positive element is. For example, consider the following cases:—

Compound	Heat of formation	Compound	Heat of formation
[H, Cl, Aq]	39315	[H, Cl, Aq]	39315
[H, Br, Aq]	28380	[H, I, Aq]	13170
Difference	10935	Difference	26245
[K, Cl, Aq]	101170	[K, Cl, Aq]	101170
[K, Br, Aq]	90230	[K, I, Aq]	75040
Difference	10940	Difference	26130

Now the reason of this is perfectly obvious in the light of the laws of solution. Any variation from the above differences in the heat of formation of the undissolved salt is at once counter-balanced by the heat of solution, which varies inversely. Thus:—

Compound	Heat of formation	Heat of solution	Total
[H, Cl]	22000	17315	39315
[H, Br]	8440	19940	28380
Difference	13560	-2625	10935
[Na, Cl]	97690	-1180	96510
[Na, Br]	85770	-190	85580
Difference	11920	-990	10930

and so on in other cases.

WM. DURHAM

Ice on the Moon's Surface

IN May 1884 Mr. Peal, of Sibsagar, in Assam, who has studied the moon's surface with great attention, sent me a paper in which he maintained views closely resembling those of Capt. Ericsson (NATURE, p. 248) on the glacial origin of the lunar craters. In my answer I suggested that it was difficult to admit the existence of ice on the moon's surface, without a layer of water vapour over it, and that the telescope proves that if such vapour exists it is only in extraordinarily small quantities. It seems due to Mr. Peal, who was undoubtedly ignorant of Capt. Ericsson's paper of 1869, to draw attention to the correspondence. I am not sure whether the paper has been yet published.

Cambridge, July 17

G. H. DARWIN

Luminous Clouds

I AM not sure of the date, but believe it was in June 1885 that I called attention in your journal to a strange effect of bright silvery lighted clouds, which remained visible in the north-west sky after sunset until nearly 11 p.m. Several times this summer I have noted repetitions of these same curiously lighted cloud-forms, but have never seen such a wonderful display of this "after-sheen" as that of this evening, July 12.

The day from 11 a.m. until 6 p.m. had been wet, followed by a clear-up toward sundown, with a warm orange-coloured sunset near the horizon; above this, and extending nearly to the zenith, lay masses of brilliant and, one would almost say, self-illuminated cloud-ripples looking like an inverted sea of frosted silver or mother-of-pearl.

There was a strongly-marked focus in the light above the place of the sun, but it extended far beyond that both north and west. The vapour forming these cloud-waves, and which received this intense white light, must, I think, have been at a great elevation, for though all the lower vapour near the horizon retained its usual orange glow long after sunset, there was never any indication of colour upon these clouds from the beginning of the effect, about 7.30 p.m., until it disappeared soon after 10 p.m. The moon, which was in the southern part of the sky, looked quite warm in colour when contrasted with the almost bluish-white glare upon this vapour.

ROBT. C. LESLIE

Moirs Place, Southampton, July 12

THE luminous night clouds seen here on the 22nd ult. (NATURE, July 1, p. 192) have recurred, with a very remarkable development on the night of the 8th inst.

The sketches illustrate phases one hour apart from midnight to 2 a.m.; the last made solely by "cloud-light" in a window with northern aspect! The long luminous belt began to form at 11.30 p.m., fading out at 2.30 a.m. It extended obliquely from N. 10° W. to N. 30° E. in the wind's direction, which was light from N.W. Temperature subsequently fell.